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ABSTRACT

Studies of selective attention suggest a system which operates across modalities and on many forms of internal representation. Complex analysis, even semantic analysis, of sensory input may occur automatically, but attention controls the locus of action. When computations carried out by the brain are effortful, in the sense that elements compete for a common resource limited in capacity, psychologists label them as requiring attention. Such computations are often carried out serially. Processes in which activities are carried out simultaneously without interfering with one another are said to be automatic. Attention may be summoned to a particular spatial location by the presentation of a visual cue. The operation of two posterior brain systems may be involved in the selective attention: the superior colliculus for the selection of spatial location and the dorsolateral prefrontal cortex for the selection of semantic information. Investigation of spatial attention within the visual system provides a means to explore the neural systems involved in the control of attention. (JAZ)

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Cognitive Science Program

SELECTIVE ATTENTION AND COGNITIVE CONTROL

by

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Studies of selective attention suggest a system which operates across modalities and on many forms of internal representation. Complex analysis, even semantic analysis, of sensory input may occur automatically (without attention), but attention controls the locus of action. Investigation of spatial attention within the visual system provides a means to explore the neural systems involved in the control of attention.

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SELECTIVE ATTENTION AND COGNITIVE CONTROL

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Studies of selective attention suggest a system which operates across modalities and on many forms of internal representation. Complex analysis, even semantic analysis, of sensory input may occur automatically (without attention), but attention controls the locus of action. Investigation of spatial attention within the visual system provides a means to explore the neural systems involved in the control of attention.

Nearly a century ago, William James, a pioneer in the integration of knowledge from biology and psychology, wrote:

> Everyone knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration, of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others...[1]

During the past two decades the properties of attention have been more precisely defined by psychological investigations and, recently, its study has become an endeavor within the domain of neuroscience. It is now possible to explore the connections between the subjective experience of having one's attention drawn to a particular sensory event and the neural systems responsible.

Serial computation and limited capacity

When computations carried out by the brain are effortful, in the sense that elements compete for a common resource limited in capacity, psychologists label them as requiring attention. Such computations are often carried out serially. Processes in which activities are carried out simultaneously (in parallel) without interfering with one another are said to be automatic[2,3].

The importance of such a limited-capacity computation in human visual performance is clearly illustrated when one tries to detect the presence of a particular object among disparate other objects. When the object to be detected differs from other objects in the field of view by a single

feature, such as color (Fig. 1A) or orientation (Fig. 1B), it can be located easily and appears to pop out from the background. The visual computation leading to its detection is rapid and relatively independent of the total number of objects in the field of view. However, when a conjunction of two (or more) attributes needs to be detected in order to distinguish the object (Fig. 1C), the computation is effortful and time increases linearly with the number of elements in the field of view[4]. Thus, in Fig. 1, the processing of individual attributes occurs automatically, while conjoining attributes appears to require attention.

Why should attention to portions of the visual field be important in object recognition? Students of computational vision[4,5] have argued that a system which performs some types of processing only within selected regions of the visual field is advantageous over one which duplicates expensive processing apparatus at each location. A proposed hybrid system[6] consists of a parallel pre-attentive mechanism spanning the entire visual field and a more limited-capacity, focal processor.

Selection by attention

How can one measure selection by attention? When attention is directed to a particular sensory feature (e.g., spatial location, color, orientation, movement, frequency), stimuli which have this feature are processed more efficiently (faster responses, lowered thresholds) than they would be if attention is not so directed. Stimuli not having the attended feature are handled more poorly than otherwise. Thus the act of selection

by attention often results in benefits to the processing of stimuli having the attended feature and costs to the processing of stimuli not having the attended feature[2].

Experimentally, attention may be summoned to a particular spatial location by the presentation of a visual cue (Fig. 2)[2]. The cue may appear in the location to be selected or may consist of an arrow presented at fixation (in the center of the visual display) which points toward the location to be selected. After a variable interval of time a target stimulus is presented, usually in the same location as indicated by the cue (validly-cued condition) and occasionally in a location different from the one which was cued (invalidly-cued condition). Human subjects show an advantage in reaction time in the detection of a validly-cued target relative to an invalidly-cued target.

For visual location, one might be inclined to suppose that selection by attention is tied to the systems which produce eye movements in order to foveate the position of interest. However, it has been clearly demonstrated both in humans and in monkeys that one may shift attention in visual space without any overt shift in gaze. Attention may be directed covertly. Indeed, everyone has had the experience of having their attention drawn by something in the periphery of their visual field prior to the making of an eye or head movement to fixate the location of interest. While foveation produces increased acuity, a selected non-foveated area will show lower threshold[7] and faster reaction time[8,9] for stimulus detection, as though the attended location was given priority into

pathways leading to action. It is not clear how much of this difference is due to facilitation of the cued location and how much to inhibition of the uncued location[9,10]

If attention is moved to a visual location and then returned to the center by the presentation of a cue at fixation, the previously facilitated location will show a specific retardation of reaction times to stimuli presented there (termed "inhibition of return") relative to other locations in the visual field[9,11,12] While the facilitation effect appears to move with the eyes (i.e., is mapped in retinotopic coordinates), the inhibition-of-return effect remains in a fixed spatial location while the eyes move (i.e., is mapped in environmental coordinates)[9]. Such an inhibition effect may have evolved to maximize sampling of the visual environment. When a movement of attention is followed by a movement of the eyes to the selected location, attention returns to fixation. If the eyes then move away from the target location, events which subsequently occur at that spatial location are inhibited from summoning attention again. The long-lasting nature of the inhibition-of-return effect (up to 2 sec) serves to bias the next few attentional shifts and subsequent eye movements toward the gathering of information from fresh locations[9,12].

Neural systems

Can we connect specific aspects of selective attention to the neural systems which support it? Selective attention to visual locations is an important aspect of selective attention which humans share with other

animals, and it has been through investigations of visual-spatial attention that connections are beginning to be made between mental operations related to performance and the underlying anatomy and physiology.

When one shifts covertly from one visual location to another, three component mental operations are involved. First is to "disengage" attention from its current focus, next attention must "move" to the target, and finally it "engages" the target[9]. Cueing experiments with visual-spatial attention indicate that the full advantage of a validly-cued trial over an invalidly-cued trial occurs by 150 msec after the presentation of the cue[2,9]. Thus, in this time attention has disengaged from fixation, moved to and fully engaged the target location. The importance of the time to disengage has been stressed recently in studies of saccades latencies in monkeys and humans[13]. It was found that the time required to initiate an eye movement to a peripheral target location decreases dramatically if the subject is permitted to first disengage attention from fixation.

Patients with lesions of the posterior parietal lobe of the cerebral cortex often manifest a syndrome called neglect - disregard of stimuli in spatial locations contralateral to the side of their brain lesion. These patients usually recover from neglect over the months following the lesions, however, they continue to show greatly increased reaction times when an invalidly-cued target appears on the side contralateral to their brain lesion[14]. These same patients may show normal ability in responding to the target once they have been correctly cued and also equal ability to move attention to the cue on either side. Such findings suggest little or

no loss in the move or engage operations in the presence of massive deficit in the disengage operation. Once visual attention in these patients is engaged they have great difficulty disengaging it to a target which is further from the side of the lesion than their current focus of attention.

The findings from parietal patients contrast sharply with what is found in patients with midbrain lesions producing a loss in the ability to make saccadic eye movements. These patients show reduction in the speed of moving attention, in directions for which no saccadics are possible, but no specific deficit in the disengage operation[15]. These same midbrain patients show no evidence for inhibition of return, although patients with parietal lesions are normal in this regard (as also are patients with frontal and basal-ganglia lesions)[12].

Studies of the properties of nerve cells in the primate superior colliculus indicate that many cells show facilitation of their responses to visual stimuli prior to the initiation of eye movements to the stimuli. Thus the superior colliculus appears to be involved in controlling eye movements to spatial locations following selection of these locations by attention. Nerve cells in the primate posterior parietal cortex and lateral pulvinar exhibit facilitation of their responses to attended stimuli even in the absence of eye movements, and are thus involved in covert shifts of attention[16,17]. Recent studies using a peripheral cueing task (Fig. 2) with alert monkeys found that microinjections of GABA-agonistic or GABA-antagonistic agents into the pulvinar selectively speeded or slowed covert shifts of attention in the spatial direction contralateral

to the injection site[18]. These studies provide a start toward understanding the components of visual-spatial attention in terms of midbrain and cortical neurophysiology.

The role of selective attention in conjoining attributes during visual perception is also beginning to find correlates at the neural level. The recognition of objects involves the processing of the dispartate features characterizing the object, a process that entails information-transmission from the striate cortex (visual area VI), through various extrastriate visual areas (V2, V3, VP, V4), to the inferior temporal cortex (IT)[19,20]. At each successive stage along this pathway there is an increase in the size of the receptive fields of the neurons. Large receptive fields may underlie the ability to recognize objects regardless of location and it appears that selective attention permits the analysis of an individual object out of many possible objects which may be present within the large receptive field of a cortical neuron. Nerve cells in areas V4 and IT have been found to respond specifically to attended stimuli when there are several stimuli within their receptive fields[21]. Selective attention thus results in unvanted information being filtered from the receptive fields of neurons in these cortical areas.

Attention and language

Because of the convergence of human performance and single cell recording data in the area of visual-spatial attention it may be possible to use it as a model for understanding the anatomy of other forms of

attention. Psychologists are particularly interested in the processing language. One way of summarizing ideas about the role of attention in processing visual language is shown in Figure 3[22]. The figure suggests that sensory input can automatically activate internal visual, phonetic (word name) and semantic (word meaning) representations. Attention may also select any of these representations for further processing. For example, one may conjure up a visual representation (an image of the word), or the word name may be used in tasks such as constructing rhymes, or the semantic representation may be used in generating related words.

When a person attends to a location in visual space we have revieved evidence that information at that location is processed more efficiently and at other locations less efficiently. Similarly when one selects a word to pay attention to, related words appear facilitated and unrelated ones are processed more slowly[23]. There is another way of varying momentary efficiency of processing which appears to behave differently. Suppose you are asked to determine as quickly as possible whether or not a target string of letter (e.g., NURSE or NURTE) is a word. If prior to receiving the target string a related word (e.g., DOCTOR) is presented the classification of the target as word or non-word will be more efficient (more rapid and with fewer errors)[23,24]. Semantic priming of this type may occur automatically even when you are trying to ignore the prime. When automatic priming occurs, it acts mainly to improve the processing of the primed item over a control where no prime is presented, but it usually does not retard very much the processing of items which are unrelated to the prime[2]. On the other hand, priming may also result from a purely internal

intention to think about a particular category[23]. In this case it must involve attention and usually a combination of facilitation of related items and inhibition of items in other categories is observed[23].

Two other factors support the automatic nature of priming. Priming has been shown to occur when the prime is presented at speeds so rapid that people deny it occurred[25,26,27]. Moreover, automatic priming seems to follow rules which are different than when the prime is attended. When one attends to a particular meaning of a word (e.g., palm as part of the hand), priming is limited to words related to that meaning (e.g., head, but not oak); however, for unattended primes words related to either meaning appear to be facilitated[26]. In addition, in the attended case, the more predictive the prime is of what is to follow, the stronger will be the priming effect; this relation of probability to priming strength does not occur for unattended primes[27].

Patients with posterior lesions of the left hemisphere may suffer from severe deficits in semantic processing called Wernicke's aphasia. They do very poorly in making judgements of the relationship between words and their spontaneous speech is often fluent in grammatical form but empty of content. Studies of semantic priming using these patients show large effects of semantic priming on their ability to judge whether a letter string is or is not a word[28]. These findings indicate that such patients have normal activation of semantic memory by words but are not able to use the activation pattern to make deliberate judgements. It is possible that Wernicke's area may be part of the circuitry controlling the semantic

network in a way analogous to the role of the parietal lobe in the control of visual-spatial stimuli. If this proves to be correct it would allow us to make more detailed comparisons of two distinct posterior attentional systems. Such an analysis could greatly enlarge our understanding of the neural systems related to attention.

Cognitive control

We have discussed the operation of two posterior brain systems that may be involved in selective attention. One is for the selection of spatial location and one is involved with the selection of semantic information. Are these independent modules or are they part of a more general attentional system? This has been a controversial issue within psychology. Dual-task studies have always shown some independence between spatial and language processing[29]. Nonetheless, there is also evidence that, for example, attending to language information can interfere with processing spatial cues. This interaction not only delays responding but can retard the shift of visual attention as well[30,31]. Moreover, the ability of parietal patients to attend normally to validly cued targets presented to the damaged hemisphere suggests that the source of the attention effect must lie outside the damaged parietal lobe.

It is obviously important to be able to avoid control by sensory stimulation in order to perform many cognitive tasks. Just as posterior attentional systems act to select candidate sensory stimuli, it is possible that higher levels of the system act to prevent sensory events from inappropriate control of performance.

A number of lines of evidence suggest that the dorsolateral prefrontal cortex may play an important role in this higher level of attention. Anatomical and cerebral blood flow studies illustrate the close connections between the parietal cortex and this area of the frontal lobe[32]. Studies of patients with lesions of this area show a reduction in the EEG signs related to early selection of auditory information and these patients that show related performance decrements[33]. Similar deficits in event related potential have been found in schizophrenic subjects[34], who have been described as lacking higher levels of attentional control[35]. Furthermore, blood flow studies of schizophrenics involved in shifting attention between the different stimulus dimensions of color, form and number in a card sorting task have shown a deficit that is most apparent in the dorsolateral prefrontal cortex[36].

The deficits found in adult patients with frontal lesions indicate their difficulty in maintaining coherent programs designed to reach a goal[37,38]. They are frequently distracted from the goal by sensory events as though they were less able than normals to control activation induced by sensory events. An analogy between monkeys with frontal lesions and the developmental stages of human infants has been observed in a goal directed task of reaching for a visible object presented within a plexiglass box. The infants, like monkeys with frontal lesions, seem remarkably constrained to reach following the line of sight even when that means contacting a closed side, rather than being able to reach through the opening to retrieve the object[39]. There is a long period of development required for infants to achieve adequate inhibitory control over immediately present sensory events[40].

These findings provide a start toward understanding how frontal areas may become involved in determining whether or not selected sensory information will influence performance. This skill must be of great importance in our ability to achieve a coherent program of performance in the service of internally stored goals. A more exact understanding of the anatomical substrates of this form of attention should help our understanding of the wide variety of conditions that have been considered to be attentional disorders.

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Figure 3. A view of nervous-system organization while reading words. The three major internal representations (codes) are called visual, phonetic and semantic. Spelling-pattern codes (sp) are constructed from representations of alphabetic letters, which in turn are constructed from representations of component orientations. In reading a word, information may be processed via a visual code for the word, v(v), through a phonetic code, p(v), and finally to a representation of the word's meaning, m(v). Codes for word meanings are combined to yield representations of meaning for word groups, m(vg). Other pathways might proceed from visual sep-codes to phonetic sp-codes and thence to p(v). Fluent readers can pass from visual directly to semantic representations. The results from unconscious priming experiments indicate the possibility of passing from a primitive visual code directly to meaning. Most of the indicated pathways can be activated automatically, without the aid of attention (the circled A). Attention is left free to integrate the discourse into a meaningful whole, but can also be brought to bear on any of the internal representations. Adapted from Ref. 22.

Figure 1. Automatic and effortful processing in human visual performance. In each case the disparate object is the quadrant in the upper left corner. When it differs in (A) color or (B) form alone, the quadrant pops out from the background. When a conjunction (C) of color and form is needed to distinguish the quadrant, boundary tracing becomes effortful.

Figure 2. Summoning attention with a visual-spatial cue. At time 1 the subject examines a display of three boxes, each separated by 7 degrees. At time 2 one of the peripheral boxes brightens, cueing the subject's attention. At time 3 a target stimuli appears on the side of the cue (validly-cued target) or on the opposite side (invalidly-cued target). The subject responds to the appearance of the target by pressing a key. Throughout an experimental trial, the subject's eyes remain focussed on the spot in the central box.

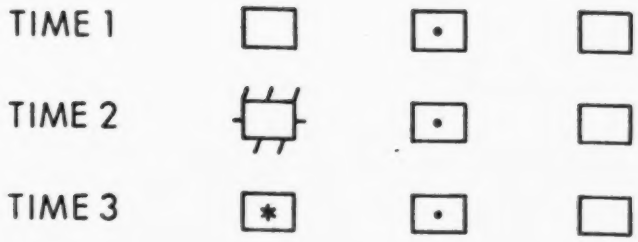

FIGURE 2

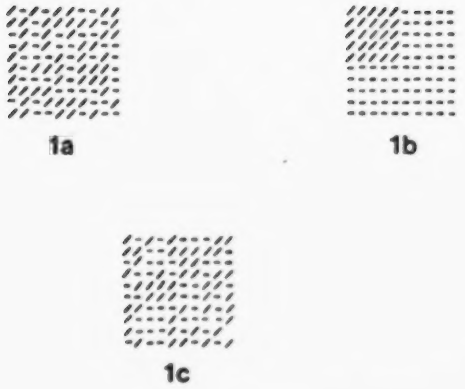

FIGURE 1

Selected references

1 James, W. (1890) The Principles of Psychology, Henry Holt and Co., New York

2 Posner, M.I. (1978) Chronometric Explorations of Mind, Erlbaum, Hillsdale, New Jersey

3 Schneider, W. (1985) in Attention and Performance XI (Posner, M.I. and Marin, O.S.M., eds), pp. 475-492, Erlbaum, Hillsdale, New Jersey

4 Treisman, A.M. and Gelade G. (1980) Cog. Psychol. 12, 97-136

5 Hurlbert, A. and Poggio, T. (1985) Trends Neurosci. 8, 309-311

6 Ullman, S. (1984) Cognition 18, 97-159

7 Bashinski, H.S. and Bacharach, V.R. (1980) Percept. Psychophys. 28, 241-248

8 Eriksen, C.W. and Hoffman, J.E. (1973) Percept. Psychophys. 14, 155-160

9 Posner, M.I. and Cohen, Y. (1984) in Attention and Performance X (Bouma, H. and Bouhuis, D., eds), pp. 531-556, Erlbaum, Hillsdale, New Jersey

10 Hughes, H.C. and Zimba, L.D. (1985) J. Exp. Psychol. Hum. Percept. Perform. 11, 409-430

11 Naylor, E.A. (1985) in Attention and Performance XI (Posner, M.I. and Marin, O.S.M., eds), pp. 189-204, Erlbaum, Hillsdale, New Jersey

12 Posner, M.I., Rafal, R.D., Choate, L.S. and Vaughan, J. (1985) Cog. Neuropsychol. 2, 211-228

13 Boch, R., Fischer, B. and Ramsperger, E. (1984) Exp. Brain Res. 55, 223-231

14 Posner, M.I., Walker, J.A., Friedrich, F.J. and Rafal, R.D. (1984) J. Neurosci. 4, 1863-1874

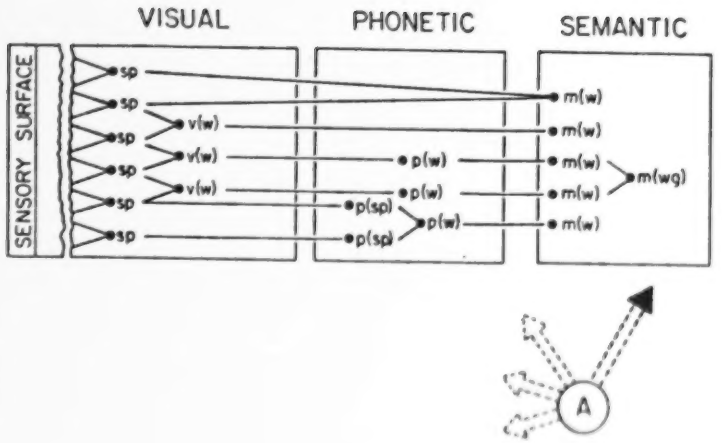

FIGURE 23

15 Posner, M.I., Cohen, Y. and Rafal, R.D. (1982) Phil. Trans. R. Soc. Lond.B 298, 187-198

16 Mountcastle, V.B. (1978) J. Roy. soc. Med. 71, 14-27

17 Wurtz, R.H., Goldberg, M.E. and Robinsin, D.L. ;(1980) Prog. Psychobiol. Phsyiol. Psychol. 9, 43-83

18 Petersen, S.E., Morris, J.D. and Robinson, D.L. (1984) Soc. Neurosci. Abstr. 10, 475

19 Van Essen, D.C. and Maunsell, J.H.R. (1983) Trends Neurosci. 6, 370-375

20 Mishkin, M., Ungerleider, L.G. and Macko, K.A. (1983) Trends Neurosci. 6, 414-417

21 Moran, J. and Desimone, R. (1985) Science 229, 782-784

22 LaBerge, D.A. and Samuels, S.J. (1974) Cog. Psychol. 6, 293-323

23 Neely, J.H. (1977) J. Exp. Psychol. Gen. 106, 226-254

24 Meyer, D.E. and Schvaneveldt, R.W. (1971) J. Exp. Psychol. 90, 227-234

25 Marcel, a.J. (1980) in Attention and Performance VIII (Nickerson, R.S., ed), pp. 435-457, Erlbaum, Hillsdale, New Jersey

26 Marcel, A.J. (1983) Cog. Psychol. 15, 197-237

27 Cheesman, J. and Merikle, P.M. (1985) in Reading Research (Besner, D., Waller, G.T. and MacKinnon, G.S. eds.), pp. 311-330, Academic, New York

28 Blumstein, S.E., Milberg, W. and Shrier, R. (1982) Brain and Lang. 17, 201-315

29 Allport, D.A. (1980) in Cognitive Psychology: New Directions (Claxton, G., ed), Routledge and Keegan Paul, London

25

30 Posner, M.I., Cohen, Y., Choate, L., Hockey, R. and Maylor, E. (1984) in Preparatory States and Processes (Kornblum, S. and Requin, J., eds), Erlbaum, Hillsdale, N.J.

31 Jonides, J. (1981) in Attention and Performance IX Long, J. and Baddeley, A., eds), Erlbaum, Hillsdale, N.J.

32 Goldman-Rakic, P.S. (1984) Trends in Neurosci. 7, 419-429

33 Knight, R.T., Hillyaard, S.V., Woods, D.L. and Neville, H.J. (1981) EEG and Clin. Neurophysiol. 52, 571-582

34 Baribeau-Braun, J., Picton, T. and Gosselin, J.Y. (1984) Science 219, 874-876

35 Callaway, E. and Naghdi, S. (1982) Arch. Gen. Psychiat. 39, 339-347

36 Weinberger, D.R., Berman, K.F. and Zec, R. (1986) Arch. Gen. Psychiat. 114-126.

37 Shallice, T. (1982) Phil. Trans. Roy. Soc. Long. B 298, 199-209

38 Duncan, J. Cog. Neuropsychol. (in press)

39 Diamond, A. and Goldman-Rakic, P.S. (1983) Soc. Neuro. Abstr. 9, 641

40 Reed, M.A., Pien, D.L. and Rothbart, M.K. (1984) Merrill-Palmer Quart. 30, 131-147

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